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Taki et al.

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(54) **INFORMATION PROCESSING APPARATUS AND CONTROL METHOD**

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(73) Assignee: **SONY CORPORATION**, Tokyo (JP)

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Related U.S. Application Data

(63) Continuation of application No. 16/018,352, filed on Jun. 26, 2018, now Pat. No. 10,262,630, which is a (Continued)

(30) **Foreign Application Priority Data**

Aug. 21, 2014 (JP) 2014-168342

(51) **Int. Cl.**
G09G 5/14 (2006.01)
G09G 5/391 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G09G 5/14*** (2013.01); ***G06F 3/012*** (2013.01); ***G06F 3/013*** (2013.01); ***G06F 3/048*** (2013.01);
(Continued)

(58) **Field of Classification Search**
None
See application file for complete search history.

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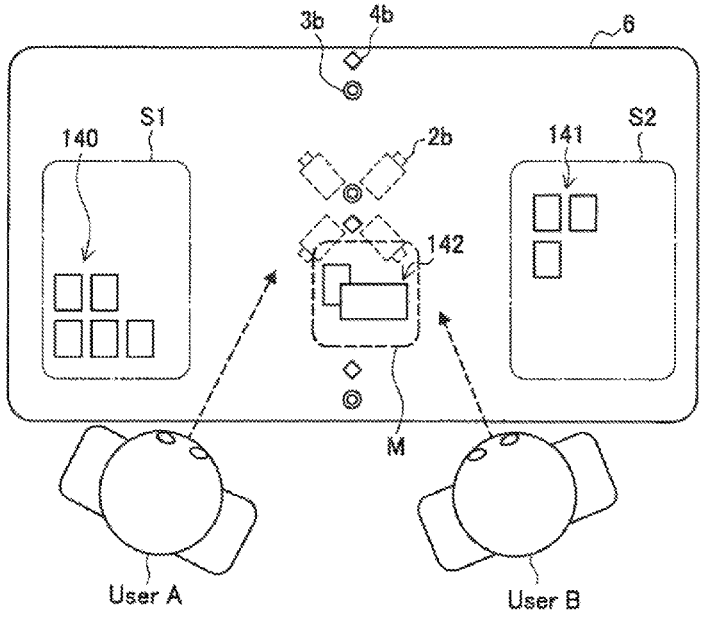
(74) *Attorney, Agent, or Firm* — Chip Law Group

(57) **ABSTRACT**

Provided is an information processing apparatus, including: a line-of-sight detection unit configured to detect lines of sight of a plurality of users with respect to presentation information; and an area determination unit configured to determine, on the basis of the detected lines of sight of the plurality of users, a shared area that is visually recognized by the plurality of users to share information and a confidential area that is not visually recognized by another user to keep information of each user confidential.

11 Claims, 13 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/503,446, filed as application No. PCT/JP2015/064769 on May 22, 2015, now Pat. No. 10,032,437.

(51) **Int. Cl.**

G06F 3/048	(2013.01)
G06F 3/01	(2006.01)
G06F 3/0484	(2013.01)

(52) **U.S. Cl.**

CPC ***G09G 5/391*** (2013.01); *G06F 3/04845* (2013.01); *G06F 2203/04803* (2013.01); *G09G 2340/0407* (2013.01); *G09G 2354/00* (2013.01); *G09G 2358/00* (2013.01)

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FIG. 1

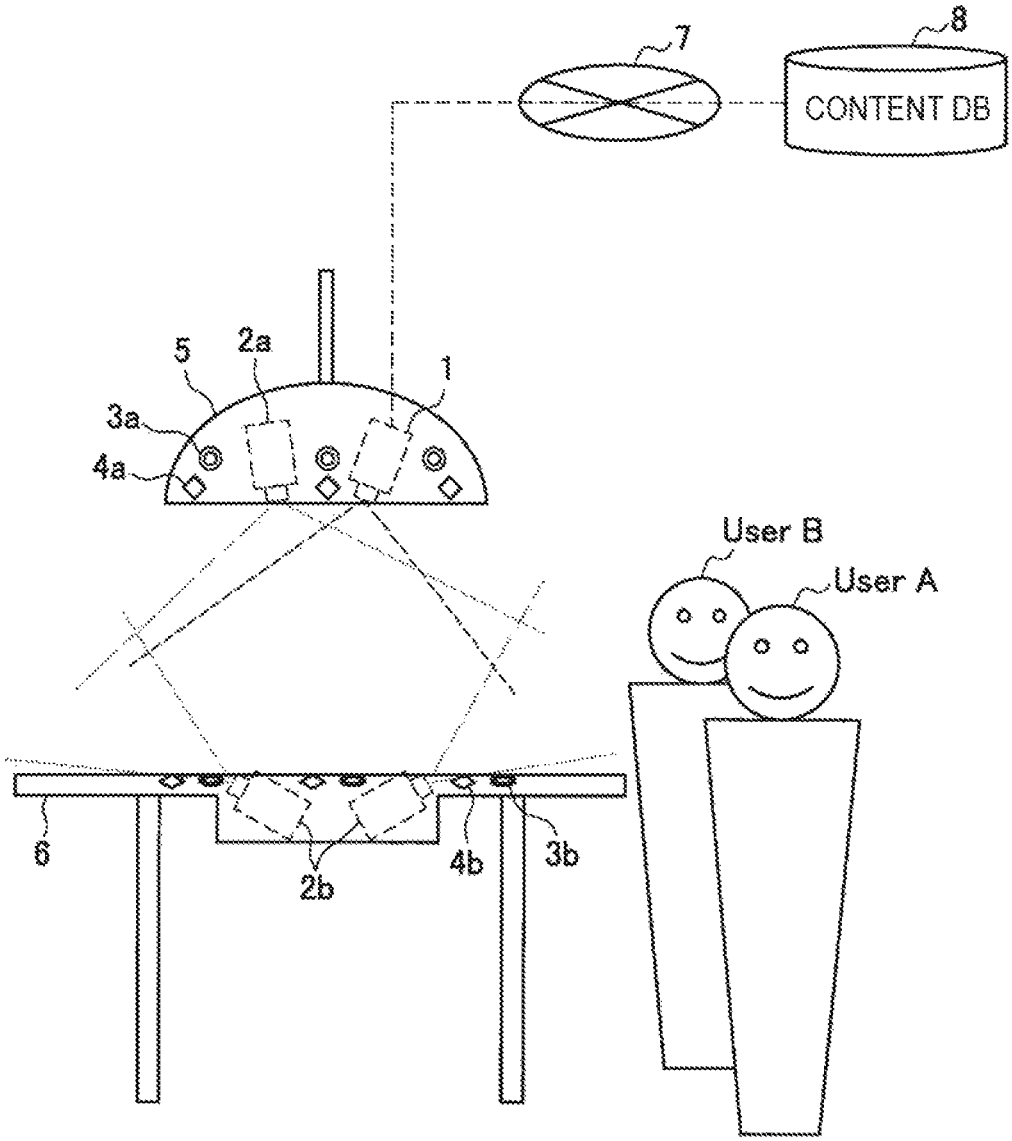


FIG. 2

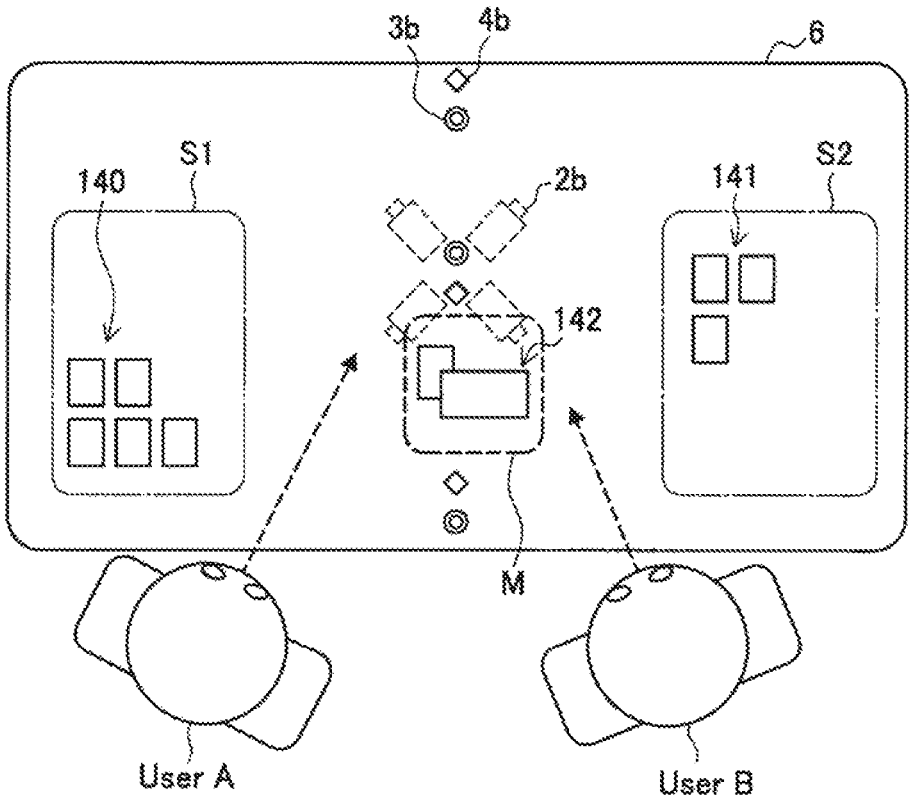


FIG. 3

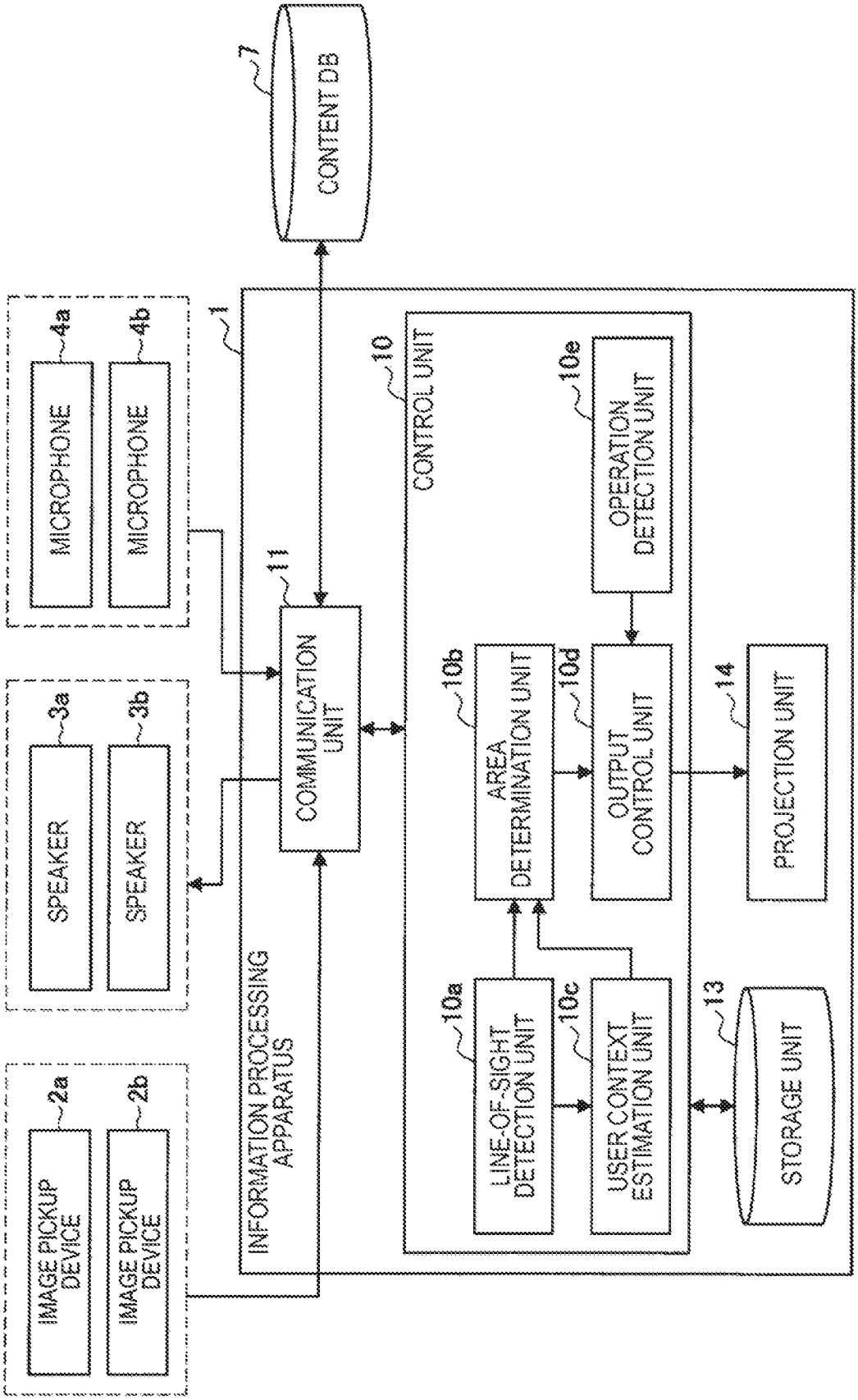

7
CONTENT DB
1
4a
MICROPHONE
4b
MICROPHONE
10
CONTROL UNIT
10e
OPERATION DETECTION UNIT
11
COMMUNICATION UNIT
10b
AREA DETERMINATION UNIT
10d
OUTPUT CONTROL UNIT
14
PROJECTION UNIT
3a
SPEAKER
3b
SPEAKER
INFORMATION PROCESSING APPARATUS
10a
LINE-OF-SIGHT DETECTION UNIT
10c
USER CONTEXT ESTIMATION UNIT
13
STORAGE UNIT
2a
IMAGE PICKUP DEVICE
2b
IMAGE PICKUP DEVICE

FIG. 4

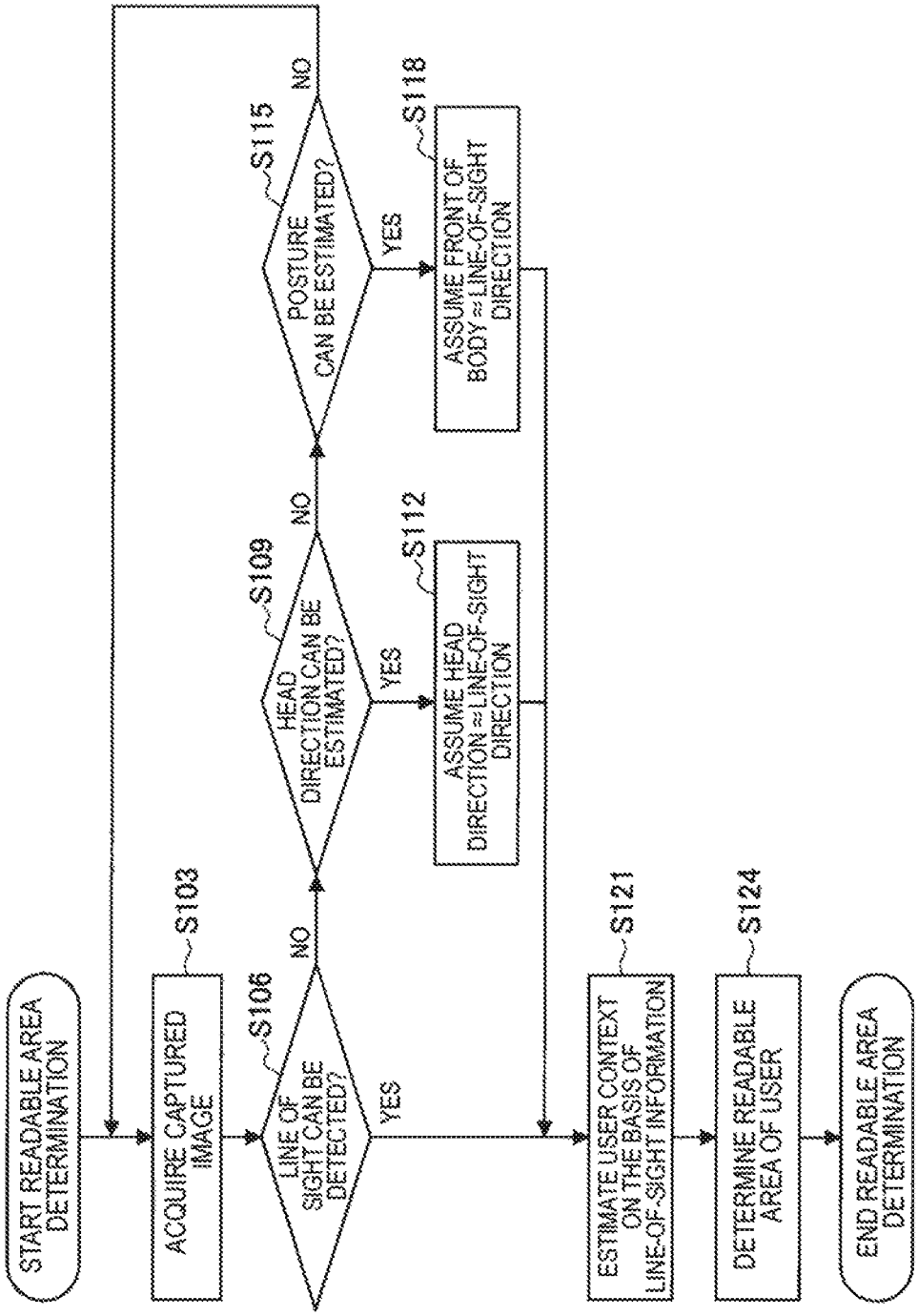

START READABLE AREA DETERMINATION
S103
ACQUIRE CAPTURED IMAGE
S106
LINE OF SIGHT CAN BE DETECTED?
NO
YES
S109
HEAD DIRECTION CAN BE ESTIMATED?
NO
YES
S112
ASSUME HEAD DIRECTION ≈ LINE-OF-SIGHT DIRECTION
S115
POSTURE CAN BE ESTIMATED?
NO
YES
S118
ASSUME FRONT OF BODY ≈ LINE-OF-SIGHT DIRECTION
S121
ESTIMATE USER CONTEXT ON THE BASIS OF LINE-OF-SIGHT INFORMATION
S124
DETERMINE READABLE AREA OF USER
END READABLE AREA DETERMINATION

FIG. 5

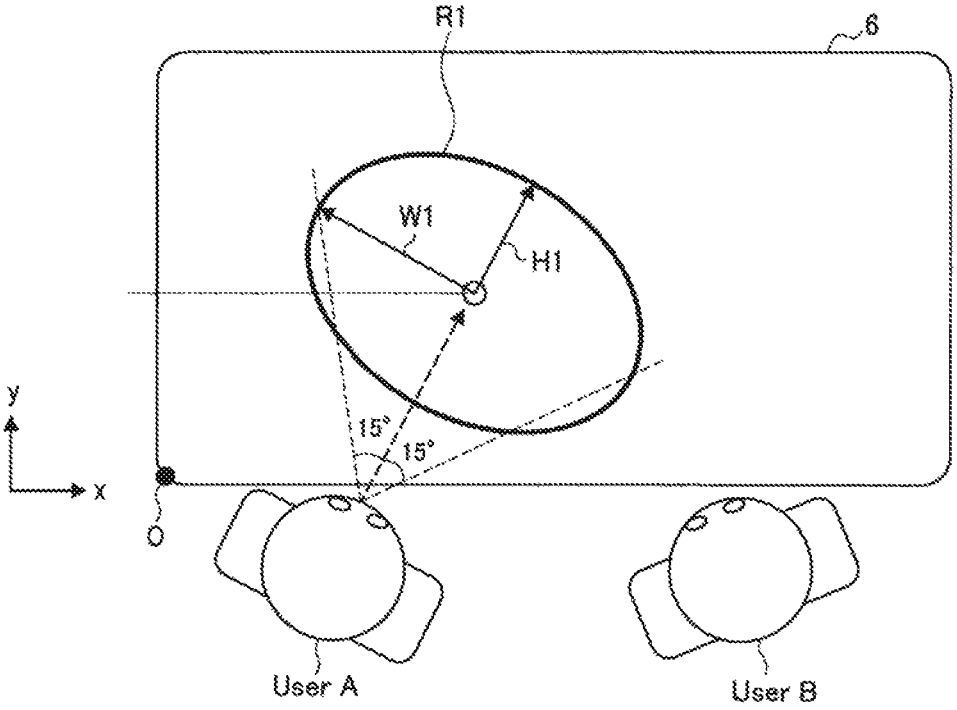


FIG. 6

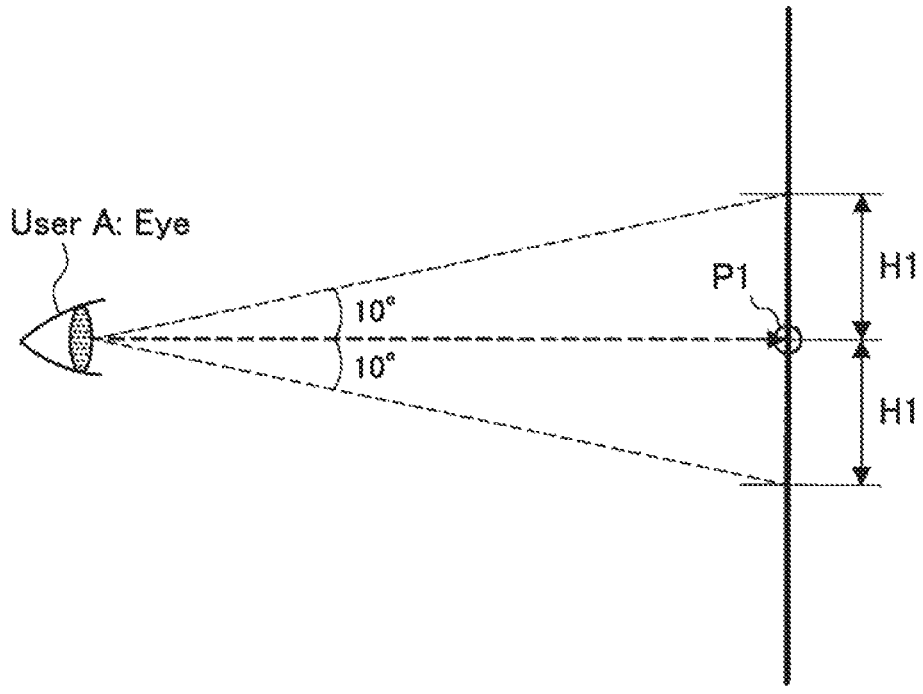


FIG. 7

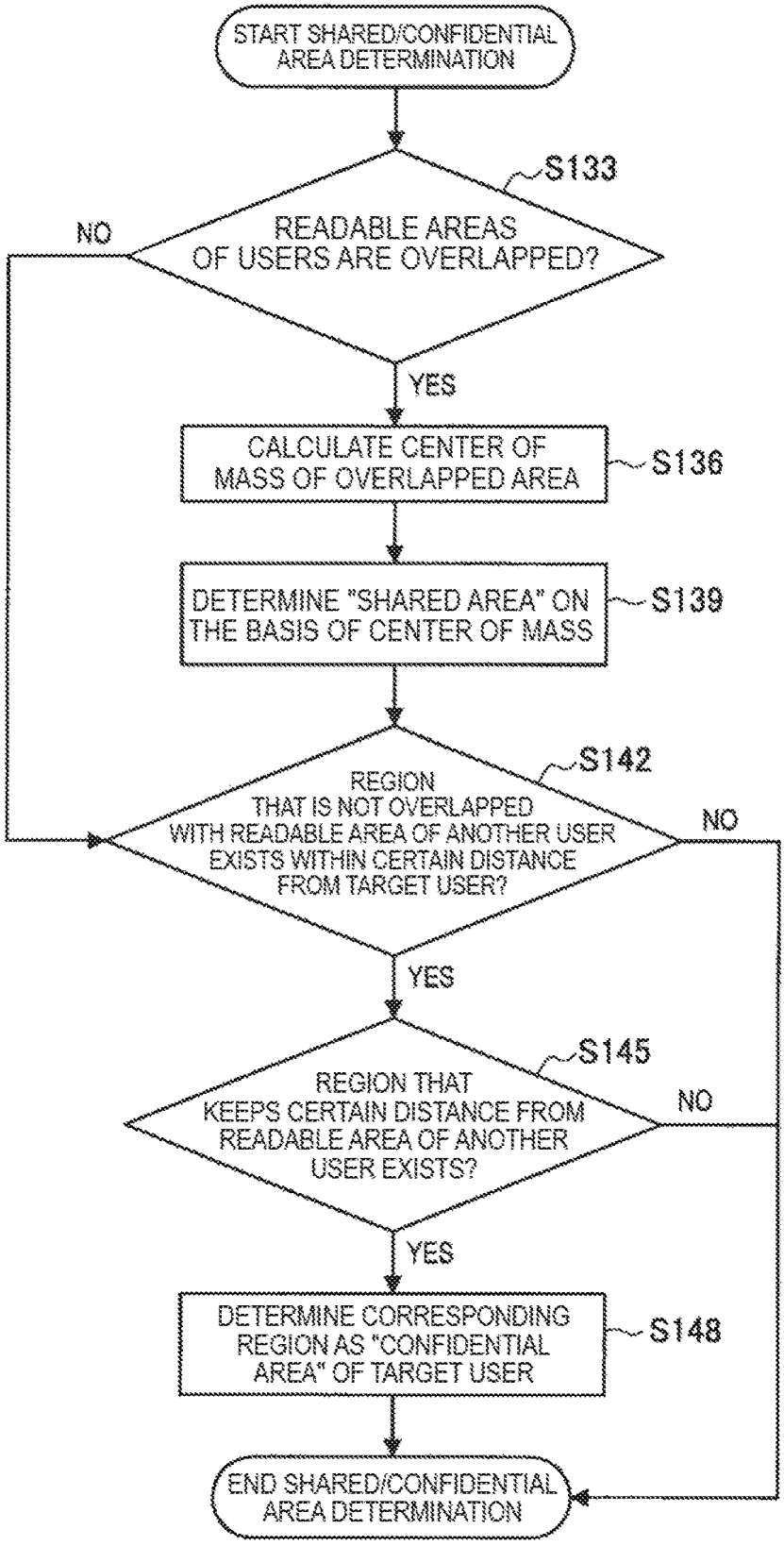

START SHARED/CONFIDENTIAL AREA DETERMINATION
S133
READABLE AREAS OF USERS ARE OVERLAPPED?
NO
YES
CALCULATE CENTER OF MASS OF OVERLAPPED AREA
S136
DETERMINE "SHARED AREA" ON THE BASIS OF CENTER OF MASS
S139
S142
REGION THAT IS NOT OVERLAPPED WITH READABLE AREA OF ANOTHER USER EXISTS WITHIN CERTAIN DISTANCE FROM TARGET USER?
NO
YES
S145
REGION THAT KEEPS CERTAIN DISTANCE FROM READABLE AREA OF ANOTHER USER EXISTS?
NO
YES
DETERMINE CORRESPONDING REGION AS "CONFIDENTIAL AREA" OF TARGET USER
S148
END SHARED/CONFIDENTIAL AREA DETERMINATION

FIG. 8

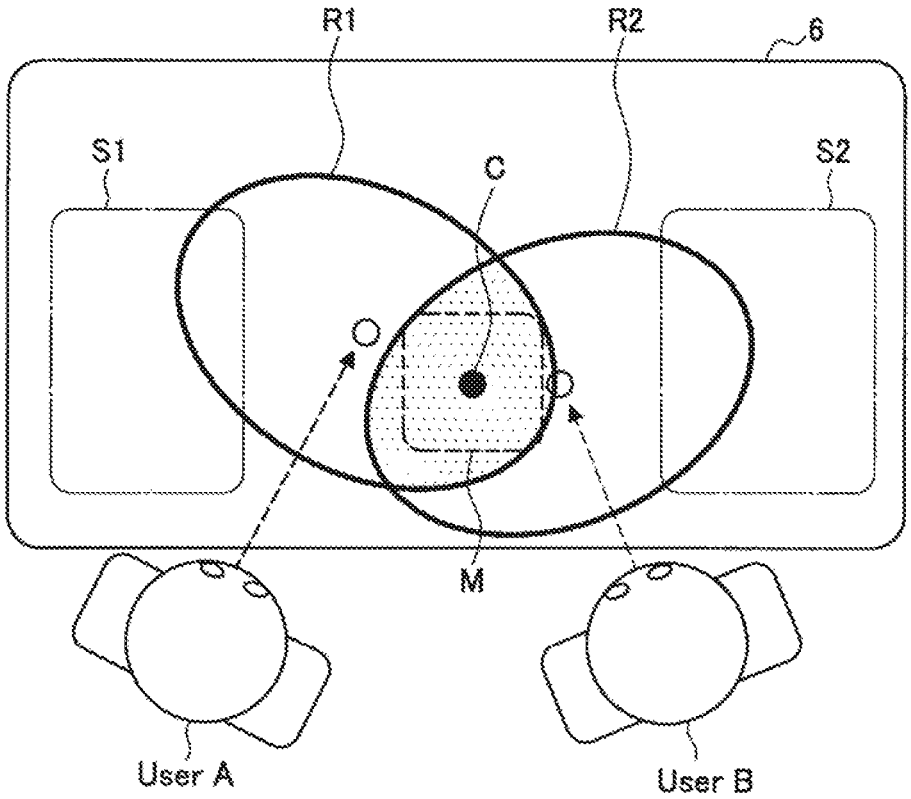


FIG. 9

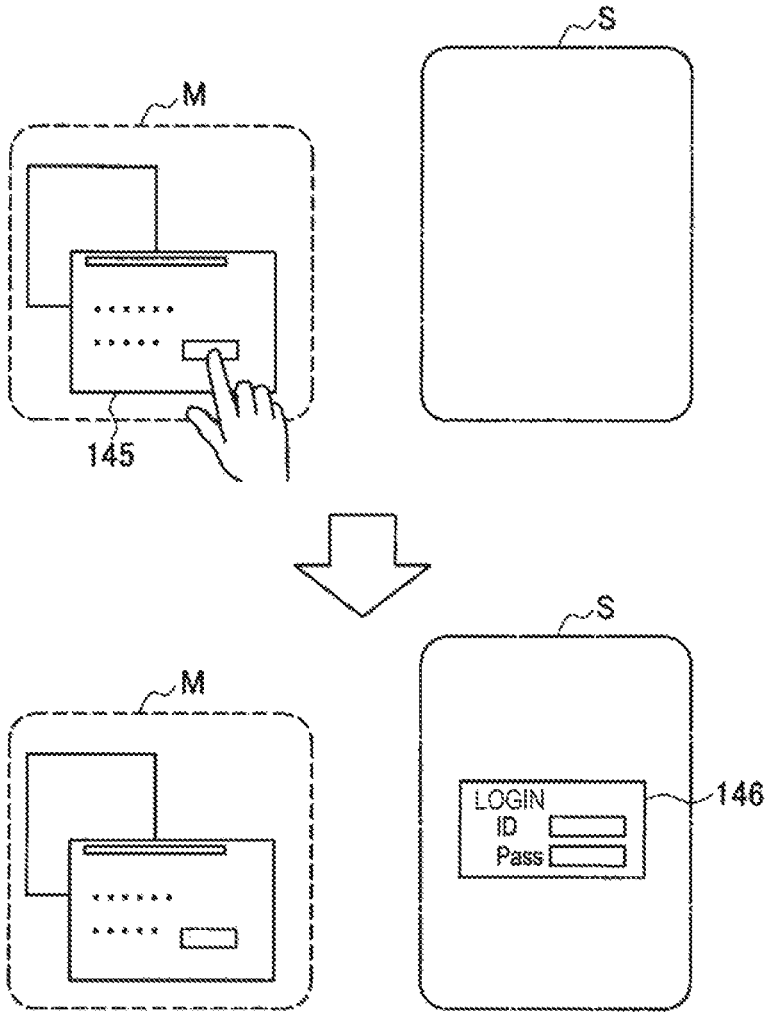


FIG. 10

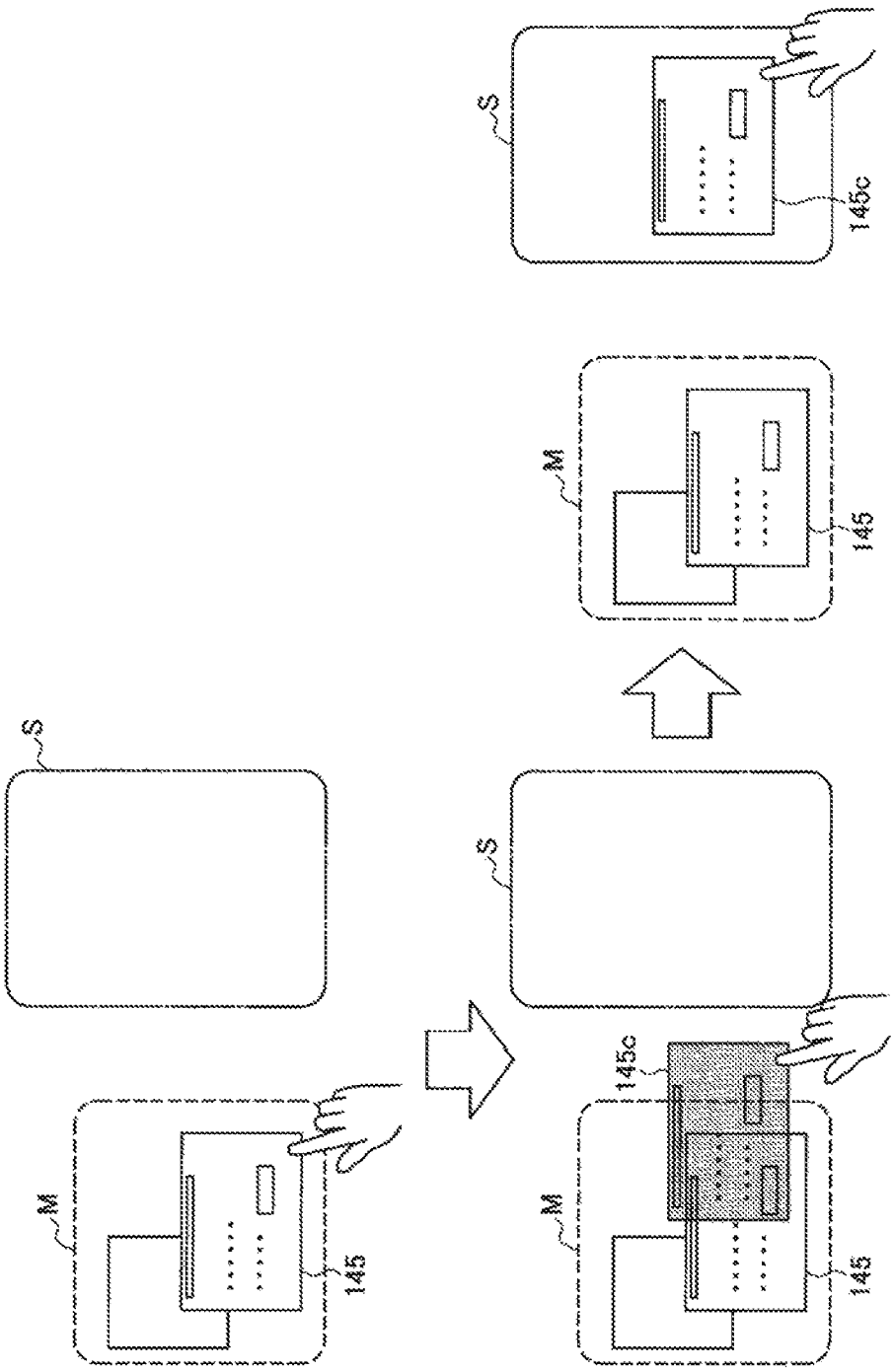


FIG. 11

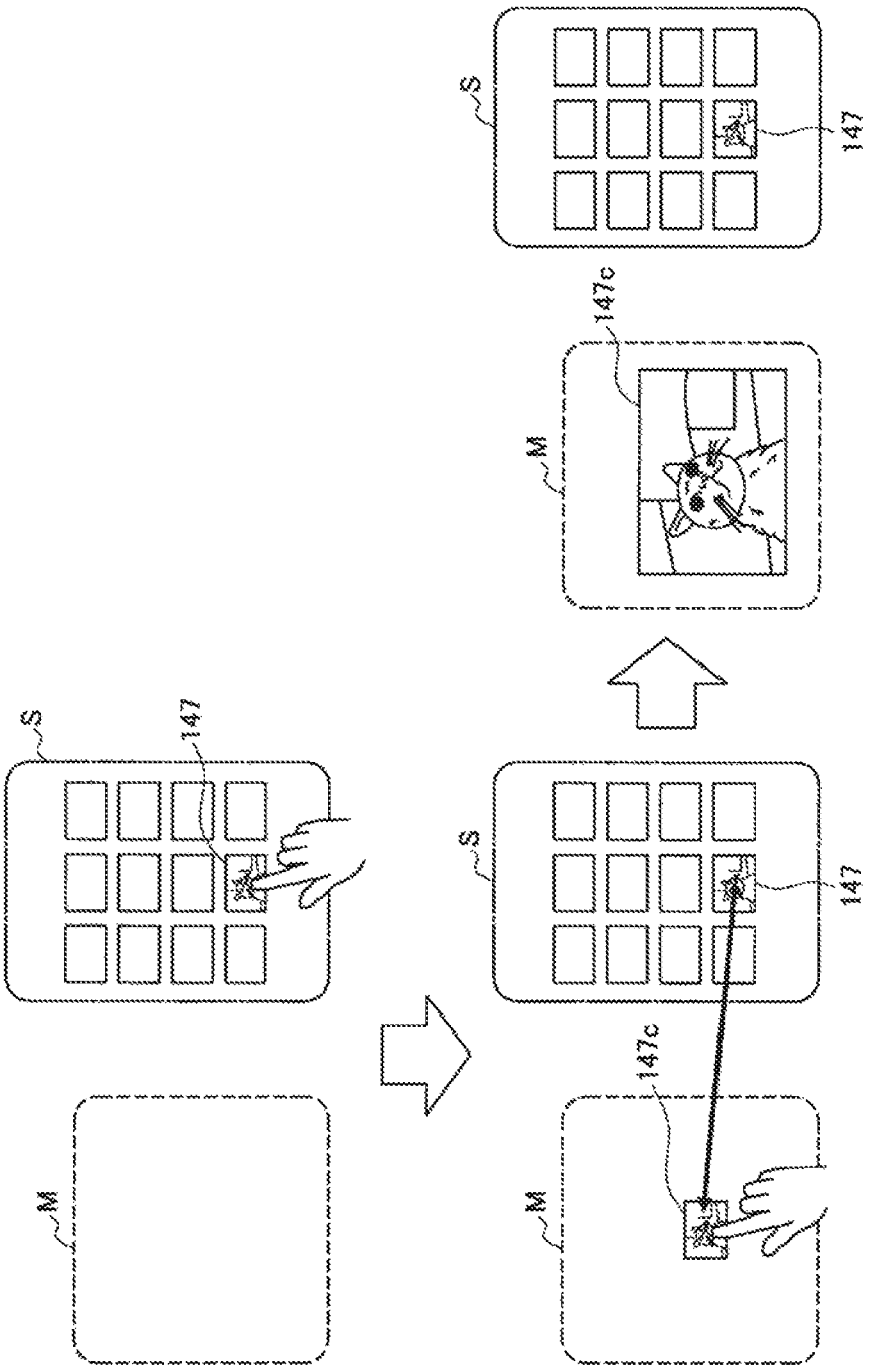


FIG. 12

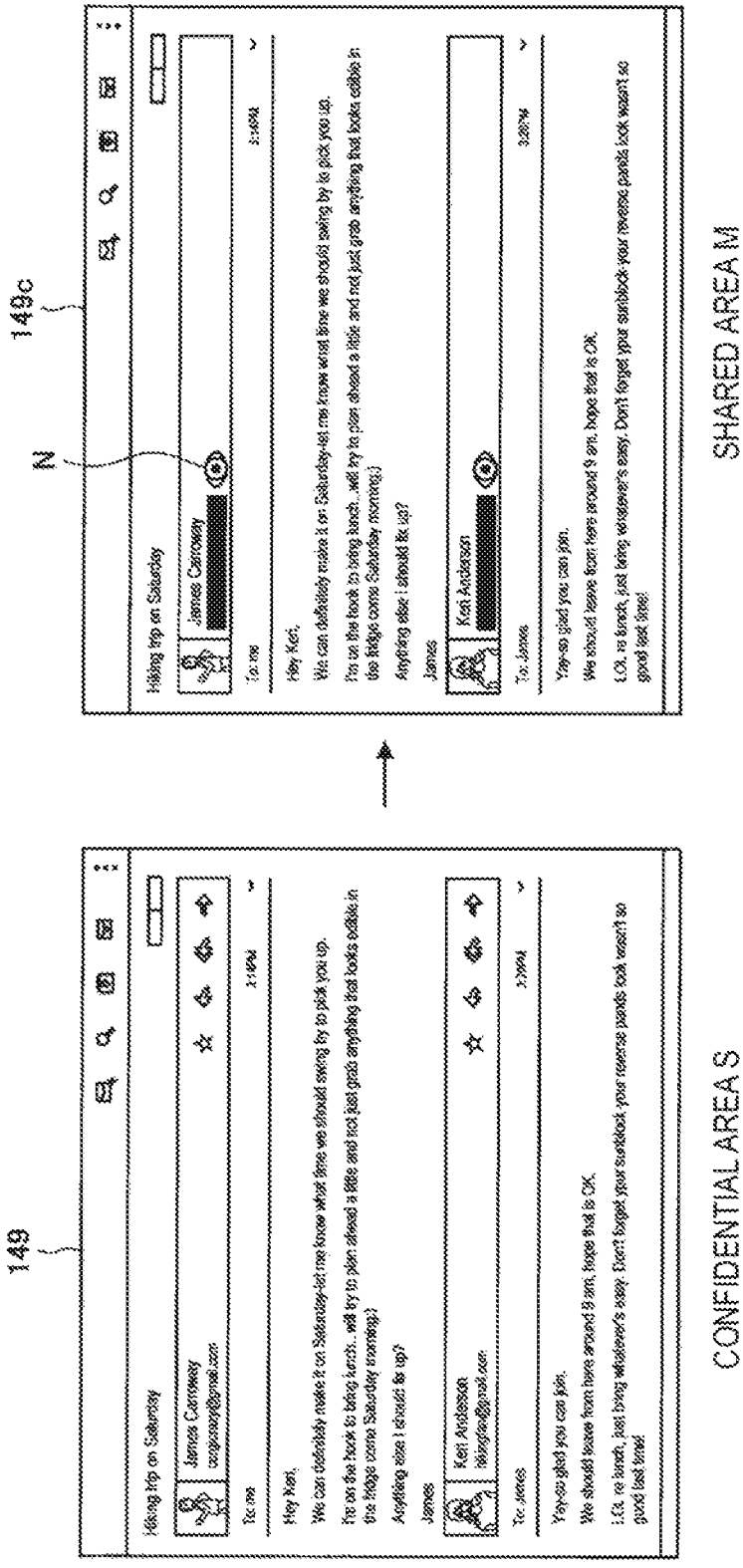

149
149c
N
Hiking trip on Saturday
James Carroway
Keri Anderson
Hey Keri,
We can definitely make it on Saturday-let me know what time we should swing by to pick you up.
I'm on the hook to bring lunch...will try to plan ahead a little and not just grab anything that looks edible in the fridge come Saturday morning:)
Anything else I should fix up?
James
Yay-so glad you can join.
We should leave from here around 9 am, hope that is OK.
LOL re lunch, just bring whatever's easy. Don't forget your sunblock-your reverse panda look wasn't so good last time!
CONFIDENTIAL AREA S
SHARED AREA M

FIG. 13

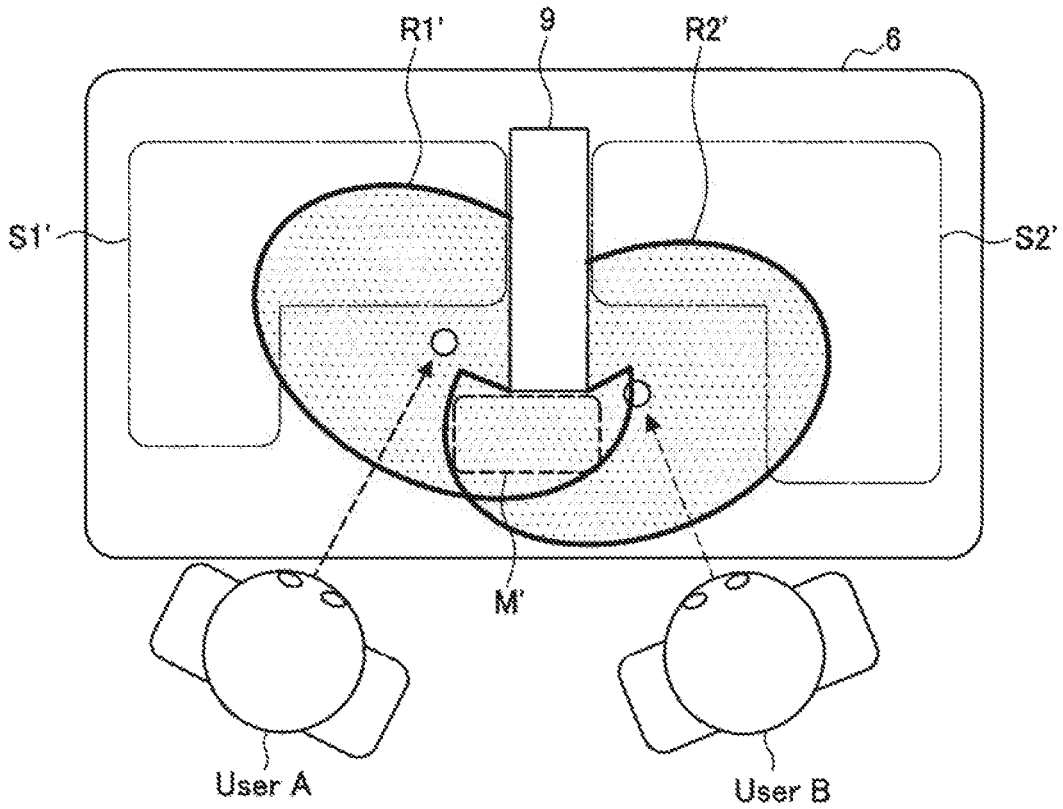
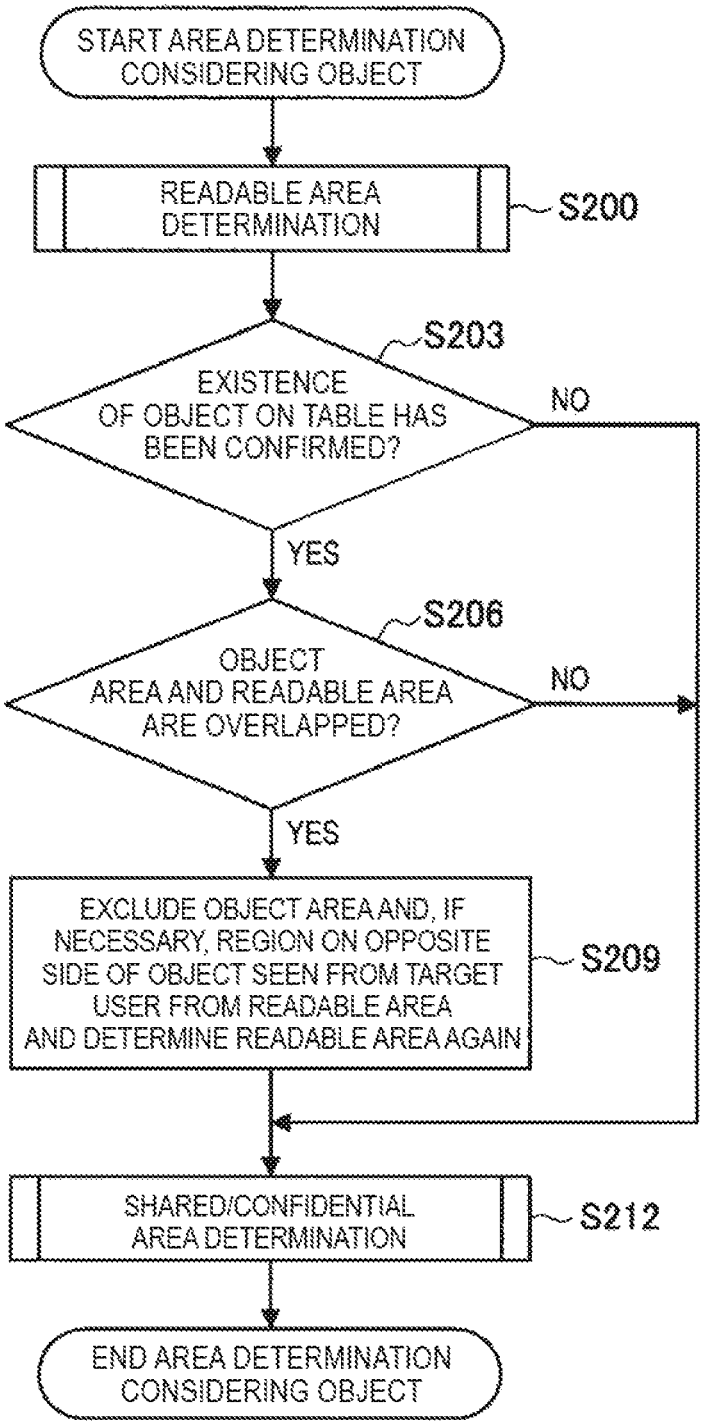


FIG. 14


START AREA DETERMINATION CONSIDERING OBJECT
READABLE AREA DETERMINATION
S200
S203
EXISTENCE OF OBJECT ON TABLE HAS BEEN CONFIRMED?
NO
YES
S206
OBJECT AREA AND READABLE AREA ARE OVERLAPPED?
NO
YES
EXCLUDE OBJECT AREA AND, IF NECESSARY, REGION ON OPPOSITE SIDE OF OBJECT SEEN FROM TARGET USER FROM READABLE AREA AND DETERMINE READABLE AREA AGAIN
S209
SHARED/CONFIDENTIAL AREA DETERMINATION
S212
END AREA DETERMINATION CONSIDERING OBJECT

INFORMATION PROCESSING APPARATUS AND CONTROL METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation application of U.S. patent application Ser. No. 16/018,352, filed Jun. 26, 2018, which is a continuation application of U.S. patent application Ser. No. 15/503,446, filed Feb. 13, 2017, which is a National Stage Entry of PCT/JP2015/064769, filed May 22, 2015, and claims the benefit of priority from Japanese Priority Patent Application JP 2014-168342 filed in the Japan Patent Office on Aug. 21, 2014, the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

The present disclosure relates to an information processing apparatus and a control method.

BACKGROUND ART

In recent years, there have been increased use cases where a plurality of people perform simultaneous operation or simultaneously look at a document. For example, a plurality of people surround a large screen (wall-surface display unit, electronic board, or the like) or a table top (table-type image display device) and conduct a meeting while looking at a document displayed on an image display device.

Regarding such an image display device that can be viewed by a plurality of people, for example, Patent Literatures 1 and 2 described below are proposed. Specifically, there are proposed techniques for, in the case where a table-type image display device displays an object serving as a document of a meeting on a display and participants of the meeting have discussions on the basis of the same object, displaying the object while enlarging the object (Patent Literature 1) or separating the object (Patent Literature 2) so that the participant who have discussions can clearly look at the object.

CITATION LIST

Patent Literature

Patent Literature 1:
Japanese Translation of PCT Patent Republication WO2010/021240

Patent Literature 2:
Japanese Translation of PCT Patent Republication WO2010/018770

DISCLOSURE OF INVENTION

Technical Problem

Herein, in an environment in which a plurality of people perform simultaneous operation, interaction based on the plurality of people such as joint viewing of an object is important, whereas it is also important to hide security information from other viewers. For example, it is necessary that confidential information, such as an input screen of a personal identification number (PIN) code and content of an email, cannot be easily viewed even in the case where a plurality of people look at a screen.

However, any of the conventional techniques described above does not mention keeping security information confidential.

In view of this, the present disclosure proposes an information processing apparatus and a control method capable of differentiating between an area that can be visually recognized only by a specified user and an area that can be visually recognized by all users on an image presentation surface that is simultaneously viewed by a plurality of people.

Solution to Problem

According to the present disclosure, there is provided an information processing apparatus, including: a line-of-sight detection unit configured to detect lines of sight of a plurality of users with respect to presentation information; and an area determination unit configured to determine, on the basis of the detected lines of sight of the plurality of users, a shared area that is visually recognized by the plurality of users to share information and a confidential area that is not visually recognized by another user to keep information of each user confidential.

According to the present disclosure, there is provided a control method including: detecting lines of sight of a plurality of users with respect to presentation information; and determining, on the basis of the detected lines of sight of the plurality of users, a shared area that is visually recognized by the plurality of users to share information and a confidential area that is not visually recognized by another user to keep information of each user confidential.

Advantageous Effects of Invention

As described above, according to the present disclosure, it is possible to differentiate between an area that can be visually recognized only by a specified user and an area that can be visually recognized by all users on an information presentation surface that is simultaneously viewed by a plurality of people.

Note that the effects described above are not necessarily limitative. With or in the place of the above effects, there may be achieved any one of the effects described in this specification or other effects that may be grasped from this specification.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a diagram showing an outline of a control system according to an embodiment of the present disclosure.

FIG. **2** is a top view of a table top shown in FIG. **1**.

FIG. **3** is a block diagram showing an example of a configuration of an information processing apparatus **1** according to this embodiment.

FIG. **4** is a flowchart showing readable area determination processing according to this embodiment.

FIG. **5** is a diagram showing determination of a horizontal direction (long diameter) of a readable area.

FIG. **6** is a diagram showing determination of a vertical direction (short diameter) of a readable area.

FIG. **7** is a flowchart showing shared/confidential area determination processing according to this embodiment.

FIG. **8** is a diagram showing shared/confidential area determination.

FIG. **9** is a diagram showing control of presentation to a confidential area performed in the case where content that needs to be secured is opened.

FIG. **10** is a diagram showing automatic copy performed when content is moved from a shared area to a confidential area.

FIG. **11** is a diagram showing optimization control performed when content is moved from a confidential area to a shared area.

FIG. **12** is a diagram showing a specific example of hiding/deleting of confidential information.

FIG. **13** is a diagram showing an outline of area determination considering object recognition according to a modification example of this embodiment.

FIG. **14** is a flowchart showing area determination processing considering an object according to the modification example of this embodiment.

MODE(S) FOR CARRYING OUT THE INVENTION

Hereinafter, (a) preferred embodiment(s) of the present disclosure will be described in detail with reference to the appended drawings. In this specification and the appended drawings, structural elements that have substantially the same function and structure are denoted with the same reference numerals, and repeated explanation of these structural elements is omitted.

Description will be provided in the following order.

1. Outline of control system according to embodiment of present disclosure
2. Basic configuration
3. Operation processing
3-1. Readable area determination processing
3-2. Shared/confidential area determination processing
4. Presentation control example
4-1. Presentation control of confidential information
4-2. Movement of content between areas
4-3. Hiding/deleting of confidential information when content is moved
5. Modification example
6. Conclusion

1. Outline of Control System According to Embodiment of Present Disclosure

An outline of a control system according to an embodiment of the present disclosure will be described with reference to FIG. **1** and FIG. **2**. In the example shown in FIG. **1**, a plurality of people (user A and user B) surround a table top **6** and have discussions while viewing information (still image, moving image, text, and the like) presented on the table top **6**. Specifically, an image is projected onto the table top **6** by a projector (hereinafter, referred to as "information processing apparatus **1**") provided in a ceiling hanging unit **5**. The user A and the user B can have discussions while looking at the image projected onto the table top **6**.

Information projected by the information processing apparatus **1** may be stored in a storage unit **13** inside the information processing apparatus **1** (see FIG. **3**; so-called local storage) or may be acquired via a network **7** from a content DB **8** (so-called web storage or server) in the network. Alternatively, the information processing apparatus **1** may be connected to an external device (mobile terminal or the like) via wireless or wired communication such as Wi-Fi (registered trademark), Bluetooth (registered trademark), or proximity wireless communication and may acquire the information from the external device.

An image pickup device **2***a* is provided inside the ceiling hanging unit **5**. The image pickup device **2***a* continuously captures an image of the table top **6** and captures an image of user operation performed on an image projected onto the table top **6**. The image pickup device **2***a* also captures an image of the users surrounding the table top **6**. An image captured by the image pickup device **2***a* is transmitted to the information processing apparatus **1**.

Speakers **3***a* and microphones **4***a* are provided in the ceiling hanging unit **5**. Each speaker **3***a* outputs sound accompanied by a projected image. For example, a video of a moving image is projected by the information processing apparatus **1** and sound of the moving image is output from the speaker **3***a*. Sound data to be output is transmitted from the information processing apparatus **1**. Each microphone **4***a* picks up sound of the users surrounding the table top **6** and transmits the sound to the information processing apparatus **1**.

As shown in FIG. **1**, image pickup devices **2***b*, speakers **3***b*, and microphones **4***b* are provided in the table top **6**. The image pickup devices **2***b* capture images of the users surrounding the table top **6** and transmit the captured images to the information processing apparatus **1**. Operation of the speakers **3***b* and the microphones **4***b* is similar to that of the speakers **3***a* and the microphones **4***a*.

Note that the image pickup devices **2***b*, the speakers **3***b*, and the microphones **4***b* provided in the table top **6** are arranged so that the plurality of image pickup devices **2***b* are differently directed as shown in the top view of FIG. **2** and pairs of the speakers **3***b* and the microphones **4***b* are dispersively provided.

BACKGROUND

Herein, there has been conventionally proposed a technique for displaying an object serving as a document of a meeting or the like on a display of an electronic board or a table-top type display device so that the object can be viewed by a plurality of people. In such a conventional technique, convenience of joint viewing among a plurality of people has been regarded as important, but hiding security information from other viewers has not been considered.

In view of this, in this embodiment, an area that can be visually recognized only by a specified user (referred to as "confidential area") and area that can be visually recognized by all users (referred to as "shared area") are differentiated on an information presentation surface simultaneously viewed by a plurality of people and information presentation control to each area is performed, and therefore it is possible to ensure security while regarding convenience of joint viewing among a plurality of people as important.

Specifically, as shown in, for example, FIG. **2**, a shared area M in which fields of view of both the user A and the user B are overlapped, a confidential area S**1** that can be visually recognized only by the user A, and a confidential area S**2** that can be visually recognized only by the user B are determined in accordance with lines of sight of the user A and the user B surrounding the table top **6**. Line-of-sight directions of the users A and B are estimated on the basis of, for example, a captured image obtained by the image pickup device **2***b* and sound data obtained by the microphone **4***b*.

In accordance with a determination result of areas, the information processing apparatus **1** performs projection control so that information (content) **140** to be seen only by the user A is presented in the confidential area S**1**, performs projection control so that information **141** to be seen only by the user B is presented in the confidential area S**2**, and performs projection control so that information **142** to be seen by all users is presented in the shared area M.

Hereinabove, the outline of the control system according to an embodiment of the present disclosure has been described. Note that the numbers and arrangement positions of the image pickup devices **2***a* and **2***b*, the speakers **3***a* and **3***b*, and the microphones **4***a* and **4***b* are not limited to the examples shown in FIG. **1** and FIG. **2**. The speakers **3** and the microphones **4** may not be provided. Next, a basic configuration of the information processing apparatus **1** included in the control system of this embodiment will be described.

2. Basic Configuration

FIG. **3** is a block diagram showing an example of a configuration of the information processing apparatus **1** according to this embodiment. As shown in FIG. **3**, the information processing apparatus **1** includes a control unit **10**, a communication unit **11**, the storage unit **13**, and a projection unit **14**.

(Control Unit **10**)

The control unit **10** is made up of, for example, a microcomputer including a central processing unit (CPU), a read only memory (ROM), a random access memory (RAM), a nonvolatile memory, and an interface unit and controls each configuration of the information processing apparatus **1**. Specifically, as shown in FIG. **3**, the control unit **10** according to this embodiment functions as a line-of-sight detection unit **10***a*, an area determination unit **10***b*, a user context estimation unit **10***c*, an output control unit **10***d*, and an operation detection unit **10***e*.

—Line-of-Sight Detection Unit **10***a*

The line-of-sight detection unit **10***a* detects a line-of-sight direction of each user surrounding the table top **6** and outputs a detection result to the area determination unit **10***b*. Specifically, the line-of-sight detection unit **10***a* detects the line-of-sight direction of each user on the basis of a captured image transmitted from the image pickup device **2***a* or **2***b*. The line-of-sight direction of the user can be detected on the basis of movement of eyes (pupils), a direction of a head, or a posture (direction of body). The line-of-sight detection unit **10***a* can also detect the line-of-sight direction of the user by analyzing a sound source direction on the basis of sound data (sound of user) transmitted from the microphone **4***a* or **4***b* and estimating a head direction or posture (direction of body) of the user. In addition, the line-of-sight detection unit **10***a* may output the detection result to the user context estimation unit **10***c*.

—Area Determination Unit **10***b*

The area determination unit **10***b* determines, on the table top **6** (presentation surface), a shared area that can be visually recognized by a plurality of users and a confidential area that is not visually recognized by other users to keep information of each user confidential on the basis of line-of-sight directions of the plurality of users detected by the line-of-sight detection unit **10***a*. Specifically, the area determination unit **10***b* determines a region in which readable areas (field-of-view ranges) of the users based on the line-of-sight directions are overlapped as a shared area and determines a region in which the readable areas of the users are not overlapped as a confidential area of each user. The confidential area may further be determined as a region that is within a certain distance from a target user and is separated by a certain distance from the shared area. Area determination processing performed by the area determination unit **10***b* will be described later with reference to FIGS. **4** to **8**.

In the case where a user context is output from the user context estimation unit **10***c* described later, the area determination unit **10***b* may adjust a size of the readable area in consideration of the user context.

—User Context Estimation Unit **10***c*

The user context estimation unit **10***c* estimates what a user is looking at (i.e., user context) on the basis of movement of a line of sight detected by the line-of-sight detection unit **10***a*. For example, the user context estimation unit **10***c* estimates whether the user is reading a sentence or viewing a moving image on the basis of movement of the line of sight of the user. Normally, a field of view of a human is reduced when he/she recognizes letters, e.g., while he/she is reading a sentence. Therefore, when the user context estimation unit **10***c* estimates what the user is looking at and outputs an estimation result (user context) to the area determination unit **10***b*, the area determination unit **10***b* can adjust the readable area (for example, can reduce the readable area in the case where the user is reading a sentence).

—Output Control Unit **10***d*

The output control unit **10***d* performs output control of presentation information in accordance with a determination result by the area determination unit **10***b*. Specifically, the output control unit **10***d* controls the projection unit **14** so that information (content) to be seen by each user is projected onto a confidential area of the corresponding user on the table top **6** and controls the projection unit **14** so that information to be seen by all users is projected onto the shared area.

The output control unit **10***d* may perform output control of sound from the speakers **3***a* and **3***b* in accordance with a determination result by the area determination unit **10***b*. That is, the output control unit **10***d* performs control so that information to be heard (for example, video sound) only by each user is output as sound from the speakers **3***a* and **3***b* while having directionality with respect to a position of the corresponding user and controls the speakers **3***a* and **3***b* so that information to be heard by all users is output as sound without having directionality (nondirectionality).

—Operation Detection Unit **10***e*

The operation detection unit **10***e* detects user operation (tapping operation, dragging operation, or the like) with respect to information presented on the table top **6**. The operation detection unit **10***e* may detect user operation on the basis of a captured image continuously captured by the image pickup device **2** or may detect user operation on the basis of a detection result by a contact/proximity detection device (not shown) such as a touchscreen provided on the whole top surface of the table top **6**. Alternatively, the operation detection unit **10***e* may detect user operation based on sound input on the basis of sound of a user picked up by the microphone **4**.

(Communication Unit **11**)

The communication unit **11** is connected to an external device via wireless/wired communication and has a function of transmitting and receiving data. The communication unit **11** according to this embodiment is connected to, for example, the image pickup device **2**, the speaker **3**, the microphone **4**, or the external content DB **7** in the network to receive a captured image, sound data, or content and transmit a control signal to issue an instruction to output sound.

(Storage Unit **13**)

A program for executing each processing of the control unit **10** is stored in the storage unit **13**. Further, various pieces of content such as a photograph, a video, and a document may also be stored in the storage unit **13**.

(Projection Unit **14**)

The projection unit **14** includes a light source, a movable mirror, an illumination optical system, a projection optical system, and the like. The projection unit **14** is a display device for projecting a video and causes light emitted from a high-luminance light source to be transmitted through, for example, a liquid crystal panel to thereby project the light onto the table top **6** (presentation surface) or the like. Specifically, light emitted from the light source is output to the illumination optical system and is transmitted through the liquid crystal panel in the illumination optical system, and thus video light is generated. The generated video light is output to the projection optical system, and the video light is projected through a projection lens or the like included in the projection optical system onto the table top **6** (presentation surface) or the like. The projection optical system has an optical axis whose direction is substantially vertical to a projection direction of the light source.

Hereinabove, the configuration of the information processing apparatus **1** according to this embodiment has been specifically described. Note that, in this embodiment, information to be presented on the table top **6** is projected from the projection unit **14** of the information processing apparatus **1**, but the present disclosure is not limited thereto. For example, in the case where a display device is provided in the table top **6**, the output control unit **10***d* of the information processing apparatus **1** instructs, via the communication unit **11**, the display device to perform presentation control of content in accordance with a determination result by the area determination unit **10***b*. The display device is made up of, for example, a liquid crystal display (LCD), an organic light-emitting diode (OLED), or the like and is extended in a horizontal direction on the table top **6**.

The configuration of the information processing apparatus **1** shown in FIG. **3** is merely an example, and the present disclosure is not limited thereto. For example, the projection unit **14** may be an external device or may include an image pickup device, a speaker, and a microphone.

3. Operation Processing

The area determination processing of the control system according to this embodiment will be described with reference to FIGS. **4** to **8**.

<3-1. Readable Area Determination Processing>

Readable area determination processing according to this embodiment will be described with reference to FIG. **4**. As shown in FIG. **4**, in Step S**103**, the information processing apparatus **1** acquires a captured image from the image pickup device **2**. Acquisition of a captured image is continuously performed, and, in the case where a plurality of the image pickup devices **2***a* and **2***b* are provided, a captured image is continuously acquired from each of the image pickup devices **2***a* and **2***b*.

Next, in Step S**106**, the line-of-sight detection unit **10***a* of the information processing apparatus **1** detects a line of sight of each user on the basis of the captured image. Specifically, the line-of-sight detection unit **10***a* analyzes eyes of the user appearing in the captured image and detects a line-of-sight direction in accordance with positions and movement of pupils or irises. The line-of-sight detection unit **10***a* can also detect the line-of-sight direction by detecting reflected light on corneas, the reflected light being obtained by irradiating the corneas with an IR LED.

Then, in the case where the line of sight cannot be detected (S**106**/No), the line-of-sight detection unit **10***a* estimates a head direction of each user on the basis of the captured image in Step S**109**. For example, in the case where an image of the eyes of the user is not captured or in the case where an image of the eyes is captured but the line of sight is not detectable on the basis of the image, it is determined that the line of sight cannot be detected. Further, in the case where the image pickup device **2** captures an image of surroundings in a wide range with a wide angle lens, the line-of-sight detection unit **10***a* enlarges the captured image to analyze the captured image. Thus, in the case where resolution thereof is low, it is difficult to detect the line of sight. Therefore, in such a case, the line-of-sight detection unit **10***a* estimates the head direction of the user on the basis of the captured image.

Next, in Step S**112**, the line-of-sight detection unit **10***a* assumes the head direction as the line-of-sight direction. With this, even in the case where an accurate line-of-sight direction of the user cannot be detected on the basis of the captured image, it is possible to perform readable area determination described later by assuming the head direction as the line-of-sight direction.

On the contrary, in the case where the head direction cannot be estimated (S**109**/No), the line-of-sight detection unit **10***a* estimates a posture of each user on the basis of the captured image in Step S**115**. Specifically, the line-of-sight detection unit **10***a* estimates a direction of a body of each user.

Next, in Step S**118**, the line-of-sight detection unit **10***a* assumes a front direction of the body as the line-of-sight direction. With this, even in the case where an accurate line-of-sight direction of the user cannot be detected on the basis of the captured image or the head direction cannot be estimated, it is possible to perform the readable area determination described later by assuming the front direction of the body as the line-of-sight direction.

Then, in Step S**121**, the user context estimation unit **10***c* estimates a user context on the basis of the detection result of the line of sight by the line-of-sight detection unit **10***a*. For example, the user context estimation unit **10***c* estimates whether the user is reading a sentence or viewing a moving image as the user context in accordance with movement of the line-of-sight direction.

Then, in Step S**124**, the area determination unit **10***b* determines a readable area of each user in accordance with the detection result by the line-of-sight detection unit **10***a*. Further, the area determination unit **10***b* refers to the user context estimated by the user context estimation unit **10***c* as necessary.

Herein, a specific example of the readable area determination performed by the area determination unit **10***b* will be described with reference to FIG. **5** and FIG. **6**. In the example shown in FIG. **5**, a readable area R**1** of the user A is determined. In the case where the whole range of the table top **6** is a presentation surface, an intersection of a line-of-sight direction of the user A and the presentation surface is set to be a fixation point P**1** and the periphery of the fixation point P**1** is determined as the readable area R**1**. The readable area R**1** is an effective field of view in the field of view of the user A, the effective field of view being a field of view in which the user can exert at least an excellent information receiving ability to recognize matters, and may be set to be, for example, a range of 15 degrees in a horizontal direction from the fixation point P**1** as shown in FIG. **5** or a range of 10 degrees in a vertical direction from the fixation point P**1** as shown in FIG. **6**. A region of the readable area determined as described above is indicated, for example, as follows.

user_id:12345,

readable_area:[x, y (fixation point P), H (short diameter), W (long diameter)]

Herein, the fixation point P is set by using an origin O shown in FIG. **5** as a base point, the short diameter H indicates a length in a vertical (longitudinal) direction in the field of view of the user by using the fixation point P as a base point, and the long diameter W indicates a length in a horizontal (lateral) direction in the field of view of the user by using the fixation point P as a base point.

The readable area determination processing described above is similarly performed for the user B, and the readable areas of the user A and the user B are output. Note that, in the examples shown in FIG. **5** and FIG. **6**, the readable area R has a unique size, such as a size having 15 degrees in the horizontal direction and 10 degrees in the vertical direction. However, the present disclosure is not limited thereto, and a plurality of levels may be set as the size of the readable area. Further, the area determination unit **10***b* may adjust the size of the readable area in accordance with the above user context. Specifically, the area determination unit **10***b* calculates the readable area by using an area enlargement coefficient (Z) that has been set in advance in accordance with the user context. The area enlargement coefficient (Z) is set to be smaller as a task needs to be more attentive. For example, the area enlargement coefficient is set to "Z=0.5" during reading and is set to "Z=0.8" during viewing a moving image.

An example of determination data of the readable area considering such setting on a plurality of levels and the user context is as follows.

user_id:12345,
100%_readable_area:[75,50,20'2,40*Z],
50%_readable_area:[75,50,40*Z,80*Z],
context:gazing_image

Hereinabove, the readable area determination processing according to this embodiment has been specifically described. Next, the area determination unit **10***b* determines a shared area and a confidential area on the basis of the determined readable area of each user. Hereinafter, specific description will be provided with reference to FIGS. **7** to **8**.

<3-2. Shared/Confidential Area Determination Processing>

FIG. **7** is a flowchart showing shared/confidential area determination processing according to this embodiment. As shown in FIG. **7**, in Step S**133**, the area determination unit **10***b* of the information processing apparatus **1** determines whether or not readable areas of a plurality of users are overlapped. For example, the readable area R**1** of the user A and a readable area R**2** of the user B are overlapped in the vicinity of the center of the table top **6** in the example shown in FIG. **8**.

Next, in the case where it is determined that the areas are overlapped (S**133**/Yes), the area determination unit **10***b* calculates the center C of mass of an overlapped part in Step S**136**.

Then, in Step S**139**, the area determination unit **10***b* determines the shared area M on the basis of the center C of mass. The shared area M may have a maximum size in a region in which the readable area R**1** of the user A and the readable area R**2** of the user B are overlapped overlapped as shown in FIG. **8** or may have a predetermined minimum size or more on the basis of the center C of mass.

On the contrary, in the case where the areas are not overlapped (S**133**/No), shared area determination is not performed, and confidential area determination processing (S**142** described next) is performed.

Then, in Step S**142**, the area determination unit **10***b* determines whether or not a region that is not overlapped with a readable area of another user exists within a certain distance from a target user. For example, in the case where the confidential area of the user A is determined, the area determination unit **10***b* determines whether or not a region that is not overlapped with the readable area R**2** of the user B within a range obtained by drawing a circular arc with an average length of an arm around a position of the user A.

Next, in the case where a region that is not overlapped with the readable area R of another user exists (S**142**/Yes), the area determination unit **10***b* determines whether or not a region that keeps (is separated by) a certain distance from the readable area R of the another user exists in Step S**145**.

In the case where there is no region that is not overlapped with the readable area of the another user within the certain distance from the target user (S**142**/No) or in the case where there is no region that keeps the certain distance from the readable area R of the another user (S**145**/No), the confidential area determination is not performed, and the determination processing is terminated.

Then, in the case where there is a region that keeps the certain distance from the readable area R of the another user (S**145**/Yes), the region is determined as the confidential area S of the target user in Step S**148**. For example, as shown in FIG. **8**, a region that is within a certain distance from the user A, is not overlapped with the readable area R**2** of the user B, and keeps a certain distance from the readable area R**2** is determined as the confidential area S**1**. Such confidential area determination is performed for all users, and the confidential areas S**1** and S**2** of the respective users are determined.

4. Presentation Control Example

Hereinabove, the configuration of the control system and the area determination processing according to this embodiment have been specifically described. Next, presentation control and the like performed by the information processing apparatus **1** on the basis of an area determination result will be described with reference to FIGS. **9** to **12**.

<4-1. Presentation Control of Confidential Information>

In this embodiment, the output control unit **10***d* of the information processing apparatus **1** performs control so that information that needs to be secured (confidential information) is presented in the confidential area S. What kind of information is presented in the confidential area S is determined in accordance with predetermined definition information. This definition information may be set by a user, may be automatically set on the basis of a user's operation history, or may be updated by, for example, an update of software.

For example, as shown in FIG. **9**, in the case where content **145** is operated in the shared area M and content that needs to be secured (for example, input screen of PIN code, input history display screen, or viewing history display screen) is opened, the output control unit **10***d* performs control so that such content **146** that needs to be secured is presented in the confidential area S. With this, it is possible to prevent unintentional information leakage in the case where a plurality of people perform simultaneous operation/viewing.

Further, in the case where an image gallery, an email screen (transmission/reception box), or the like is opened, the output control unit **10***d* may perform control so that the image gallery, the email screen, or the like is displayed in the confidential area S. Because the user moves only a necessary content to the shared area M and shares the content, it is possible to prevent unnecessary information leakage.

In the case where the above content that needs to be secured is content accompanying sound such as a moving image and a directional speaker is connected, the output control unit **10***d* performs sound output control so that the sound is transmitted only to an owner user of the content.

Note that, in the case where there is no highly confidential area, the output control unit **10***d* may also perform control so that, before the content that needs to be secured is presented, for example, a dialog or the like is presented to the user and the user gives approval, and thereafter the content is presented in the shared area M.

Further, the output control unit **10***d* may also perform control so that the content is presented with a low resolution in the confidential area S. With this, even in the case where the content is looked at by another user, it is possible to prevent information leakage as much as possible.

<4-2. Movement of Content Between Areas>

Then, presentation control performed in the case where a user moves content from the shared area M to the user's confidential area S or in the case where the user moves content from the user's confidential area S to the shared area M will be described with reference to FIG. **10** and FIG. **11**.

(Movement of Content from Shared Area M)

FIG. **10** is a diagram showing automatic copy performed when content is moved from the shared area M to the confidential area S. As shown in FIG. **10**, when the content **145** presented in the shared area M is selected and dragging thereof to the confidential area S is detected, the output control unit **10***d* presents content **145***c* obtained by copying the selected content **145** and moves the content **145***c* in accordance with dragging operation performed by the user. Then, when the content **145***c* is dropped in the confidential area S, the output control unit **10***d* performs control so that the content **145***c* is presented in the confidential area S.

With this, a single user's content operation does not interrupt another user viewing content. Note that the content **145** is automatically copied when the user selects the content **145** in the example shown in FIG. **10**, but the present disclosure is not limited thereto. For example, the content **145** may be automatically copied when the content **145** reaches an outer edge of the shared area M.

In the case where a directional speaker is connected, the information processing apparatus **1** performs control so that a sound volume is optimized for each user after the content is copied and sound is output to each user, and therefore it is possible not to interrupt each user viewing content.

(Movement of Content from Confidential Area S)

FIG. **11** is a diagram showing optimization control performed when content is moved from the confidential area S to the shared area M. As shown in FIG. **11**, in the case where an image gallery is displayed in the form of list in the confidential area S, a user selects content **147** to be shared with another user from the list and moves the content to the shared area M. At this time, the output control unit **10***d* performs control so that the content **147** is copied to generate content **147***c* and the content is presented with a size and a resolution suitable for viewing by a plurality of people.

As described above, the content is controlled so that, in the case where the content is presented in the shared area M, the content is presented in a state suitable for viewing by a plurality of people, and therefore it is possible to improve usability. Note that optimization of presentation of the content based on viewing by a plurality of people is not limited to the above automatic enlargement or increase in resolution. For example, a presentation position, a presentation direction, a presentation angle, or the like of the content in the shared area M may be optimized for viewing by a plurality of people.

Further, the output control unit **10***d* may perform control (adjust a speaker direction in the case where there is a directional speaker) so that, based on a detection result of a line of sight of each user, the content is presented at an optimal position for viewing by a plurality of people in the case where a plurality of users view the content and, when a line of sight of another user is removed, the content is presented at an optimal position for remaining viewing users.

In the case of content accompanying sound such as a moving image and when a directional speaker is connected, the output control unit **10***d* performs control so that the sound is output only to a user who owns the content in the confidential area S and performs control so that, after the content is moved to the shared area M, a directionality direction and a sound volume are optimized so that the content is optimally viewed by all users.

<4-3. Hiding/Deleting of Confidential Information when Content is Moved>

Next, presentation control to automatically hide/delete confidential information contained in content in the case where the content is moved to the shared area M will be described.

For example, in the case where an email box is displayed in the confidential area S, the user selects a necessary email and drags and moves the necessary email from the confidential area S to the shared area M (movement of the content to the shared area M is similar to the case shown in FIG. **11**), the output control unit **10***d* can prevent unintentional information leakage by automatically hiding or deleting confidential information (for example, address information of the email and exif information of an image) contained in the email. Definition of the confidential information to be deleted/hidden may be set as system information in advance, may be set by the user, may be automatically set on the basis of the user's operation history, or may be updated by, for example, an update of software.

Herein, a specific example of hiding/deleting confidential information will be described with reference to FIG. **12**. A left drawing in FIG. **12** shows content **149** presented in the confidential area S (herein, a list screen of sent emails is used as an example). In the case where the content **149** is moved from the confidential area S to the shared area M, the output control unit **10***d* copies the content **149**, changes a size and a resolution of a copied content **149***c* optimal for viewing by a plurality of people, and then hides/deletes confidential information.

Specifically, as shown in a right drawing in FIG. **12**, the output control unit **10***d* hides address information of emails in the content **149***c* and displays a display switching button N in the vicinity of a hidden part. The display switching button N is a button for switching hidden display of the address information of the emails, and, when the display switching button is selected, hidden display is removed and the address information of the emails can be seen. Further, operation of the display switching button N may be performed only by a user (owner) who provides the content.

Hereinabove, the presentation control according to this embodiment has been described. Note that a line of sight of a target user is temporarily directed to the confidential area S when, for example, the content is moved, but the readable area, the shared area, and the confidential area may be maintained when a time period in which the line of sight is directed to the confidential area S is within a certain time

period. Further, the area determination unit **10***b* according to this embodiment may update determination of the readable area, the shared area, and the confidential area for each predetermined time period.

5. Modification Example

Hereinabove, the control system according to this embodiment has been specifically described. In this embodiment, the table top **6** is used as an example of a presentation surface of information, and there is also assumed a case where an object (PC, book, or the like) is placed on the table top **6**. In this case, a field of view of a user is influenced in some cases depending on a position or size of the object. In view of this, considering an object placed on the table top **6** at the time of area determination will be described in a modification example of this embodiment.

<5-1. Outline>

FIG. **13** is a diagram showing an outline of area determination considering object recognition according to the modification example of this embodiment. As shown in FIG. **13**, in the case where an object **9** exists on the table top **6**, a field of view of each user is blocked by the object **9** depending on a height of the object **9**. For example, the user A cannot see an opposite side of the object **9** (user B side), and the user B cannot see an opposite side of the object **9** (user A side). Therefore, readable areas of the users are different from the readable areas R**1** and R**2** shown in FIG. **8** and are readable areas R**1'** and R**2'** obtained by removing the regions on the opposite sides of the object **9** as shown in FIG. **13**.

As described above, when the readable areas R**1'** and R**2'** are changed, a shared area M' is also changed because a region in which the readable areas are overlapped is also different. Further, confidential areas S**1'** and S**2'** of the respective users are also changed in accordance with a change in the readable areas R**1'** and R**2'**. Area determination processing considering such object recognition on the table top **6** will be described with reference to FIG. **14**.

<5-2. Operation Processing>

FIG. **14** is a flowchart showing the area determination processing considering an object according to the modification example of this embodiment. As shown in FIG. **14**, first, in Step S**200**, the area determination unit **10***b* of the information processing apparatus **1** performs normal readable area determination processing. The normal readable area determination processing is specifically the determination processing that has been described with reference to FIG. **4**.

Next, in Step S**203**, the area determination unit **10***b* determines whether or not an object exists on the table top **6**. Object recognition is performed on the basis of, for example, a captured image acquired by the image pickup device **2**. At this time, the area determination unit **10***b* recognizes a position, a size, a height, and the like of the object.

Then, in the case where it is determined that an object exists (S**203**/Yes), the area determination unit **10***b* determines whether or not an object area and a readable area are overlapped in Step S**206**. The object area is a region in which the object **9** and the table top **6** are brought into contact with each other.

Then, in the case where it is determined that the object area and the readable area are overlapped (S**206**/Yes), the area determination unit **10***b* excludes the object area and, if necessary, a region on the opposite side of the object **9** seen from a target user from the readable area and determines the readable area again in Step S**209**. In the case where the object **9** is high, a line of sight of the user is blocked, and therefore not only the object area (region hidden by the object **9**) but also the opposite side of the object **9** cannot be seen. Therefore, the area determination unit **10***b* adjusts the readable area of the target user in consideration of the position and the height of the object **9**, a positional relationship between the object **9** and the target user, and the like.

Then, in Step S**212**, the area determination unit **10***b* performs the shared/confidential area determination processing that has been described with reference to FIG. **7**.

As described above, in the modification example of this embodiment, it is possible to determine each area also in consideration of an object placed on the table top.

6. Conclusion

As described above, in the control system according to the embodiments of the present disclosure, it is possible to differentiate between an area that can be visually recognized only by a specified user (confidential area) and an area that can be visually recognized by all users (shared area) on the information presentation surface (for example, table top **6**) which is simultaneously viewed by a plurality of people. In addition, it is possible to ensure security while regarding convenience of joint viewing by a plurality of people as important by performing information presentation control in accordance with a characteristic of each area.

The preferred embodiment(s) of the present disclosure has/have been described above with reference to the accompanying drawings, whilst the present technology is not limited to the above examples. A person skilled in the art may find various alterations and modifications within the scope of the appended claims, and it should be understood that they will naturally come under the technical scope of the present disclosure.

For example, a computer program for exerting a function of the information processing apparatus **1** can be prepared in hardware such as the CPU, the ROM, and the RAM included in the above information processing apparatus **1**. Further, a computer readable storage medium in which the computer program is stored is also provided.

In the case where content cannot be optimally displayed because a shared area is small, the output control unit **10***d* may perform control so that a copy of the same content is presented in the confidential area of each user.

The information presentation surface is not limited to the table top **6** and may be, for example, a wall surface.

The line-of-sight detection unit **10***a* may dynamically switch sensing information (captured image, sound data, and the like) for use in detection of a line of sight of a user. With this, it is possible to reduce a change in line-of-sight detection accuracy caused by a sensing situation.

Further, the effects described in this specification are merely illustrative or exemplified effects, and are not limitative. That is, with or in the place of the above effects, the technology according to the present disclosure may achieve other effects that are clear to those skilled in the art based on the description of this specification. Additionally, the present technology may also be configured as below.

(1)

An information processing apparatus, including:

a line-of-sight detection unit configured to detect lines of sight of a plurality of users with respect to presentation information; and

an area determination unit configured to determine, on the basis of the detected lines of sight of the plurality of users,

a shared area that is visually recognized by the plurality of users to share information and a confidential area that is not visually recognized by another user to keep information of each user confidential.

(2)

The information processing apparatus according to (1),

wherein, on a presentation surface of the presentation information, the area determination unit determines a region in which field-of-view ranges based on the detected lines of sight of the plurality of users are overlapped as the shared area and determines a region in which the field-of-view ranges of the plurality of users are not overlapped as the confidential area.

(3)

The information processing apparatus according to (2),

wherein the confidential area is further determined as a region within a certain distance from a target user.

(4)

The information processing apparatus according to (2) or (3),

wherein the confidential area is further determined as a region separated by a certain distance from the shared area.

(5)

The information processing apparatus according to any one of (2) to (4),

wherein the area determination unit adjusts a size of the field-of-view range of each user in accordance with user context of each user.

(6)

The information processing apparatus according to (5),

wherein the user context indicates what a user is looking at and is estimated on the basis of movement of the line of sight of the user.

(7)

The information processing apparatus according to any one of (1) to (6), further including

an output control unit configured to perform output control of the presentation information presented on a presentation surface in accordance with a result of determination performed by the area determination unit.

(8)

The information processing apparatus according to (7),

wherein, in the case where information that needs to be secured is opened, the output control unit performs control in a manner that the information is presented in the confidential area.

(9)

The information processing apparatus according to (7) or (8),

wherein the output control unit performs control in a manner that information is presented in the confidential area with a low resolution.

(10)

The information processing apparatus according to any one of (7) to (9),

wherein, in the case where information presented in the shared area is moved to a confidential area of the user by user operation, the output control unit performs control in a manner that the information is copied and is presented in the confidential area.

(11)

The information processing apparatus according to any one of (7) to (10),

wherein, in the case where information presented in the confidential area is moved to the shared area by user operation, the output control unit performs control in a manner that the information is copied, is changed to have a size and a resolution suitable for shared viewing, and is then presented in the confidential area.

(12)

The information processing apparatus according to any one of (7) to (11),

wherein, in the case where information presented in the confidential area is moved to the shared area by user operation, the output control unit performs control in a manner that the information is copied, confidential information contained in the copied information is hidden or deleted, and then the information is presented in the confidential area.

(13)

The information processing apparatus according to any one of (1) to (12),

wherein the line-of-sight detection unit detects a line of sight on the basis of a line-of-sight direction, a head direction, or a posture of the user.

(14)

The information processing apparatus according to (13),

wherein the line-of-sight direction, the head direction, or the posture of the user is estimated on the basis of at least one of a captured image of the user captured by an image pickup device and sound data of the user picked up by a sound pickup device.

(15)

The information processing apparatus according to (7),

wherein the output control unit performs information display control on a display screen or information projection control on a plane of projection.

(16)

The information processing apparatus according to (15), wherein the display screen or the plane of projection is a table top.

(17)

The information processing apparatus according to (7),

wherein the output control unit performs output control of sound having directionality from a speaker.

(18)

The information processing apparatus according to (2),

wherein the area determination unit adjusts a size of the field-of-view range of each user in accordance with a recognition result of an object existing on the presentation surface.

(19)

A control method, including:

detecting lines of sight of a plurality of users with respect to presentation information; and

determining, on the basis of the detected lines of sight of the plurality of users, a shared area that is visually recognized by the plurality of users to share information and a confidential area that is not visually recognized by another user to keep information of each user confidential.

REFERENCE SIGNS LIST

1 information processing apparatus
10 control unit
10*a* line-of-sight detection unit
10*b* area determination unit
10*c* user context estimation unit
10*d* output control unit
11 communication unit
13 storage unit
14 projection unit
2, **2***a* to **2***b* image pickup device
3, **3***a* to **3***b* speaker

4, 4*a* to 4*b* microphone
5 ceiling hanging unit
6 table top
7 network
8 content DB
9 object
M shared area
S confidential area
R readable area

What is claimed is:

1. An information processing apparatus, comprising:

at least one processor configured to:

acquire visible area information of a visible area of a user of a plurality of users with respect to a presentation surface;

determine an object placed on the presentation surface;

correct the visible area information based on each of a position of the object on the presentation surface and a height of the object;

determine, on the presentation surface, a shared area for the plurality of users and a confidential area for the user, based on the corrected visible area information;

control display of content including share information and confidential information, wherein

the confidential information is displayed in the confidential area,

the share information is displayed in the shared area,

the share information not being needed to be secured, and

the confidential information being needed to be secured in the shared area;

determine a movement of the content including the share information and the confidential information from the confidential area to the shared area; and

control, based on the determination of the movement of the content, non-display of at least a part of the confidential information to one of hide or delete the part of confidential information.

2. The information processing apparatus according to claim 1, wherein the at least one processor is further configured to control the non-display of at least the part of the confidential information to fill in at least a part of the shared area where the confidential information is displayed.

3. The information processing apparatus according to claim 2, wherein the at least one processor is further configured to control the non-display of at least the part of the confidential information to fill in at least the part of the shared area with a specific color.

4. The information processing apparatus according to claim 1, wherein

the at least one processor is further configured to control display of a switching button,

the displayed switching button is configured to switch a display state of the confidential information between a first display state and a second display state,

the first display state is a display state in which the confidential information is displayed in the shared area, and

the second display state is a display state in which the confidential information is not displayed in the shared area.

5. The information processing apparatus according to claim 4, wherein the at least one processor is further configured to authorize the user to control the switching button.

6. The information processing apparatus according to claim 5, wherein the at least one processor is further configured to change an information volume based on the determination of the movement of the content of the user from the confidential area to the shared area.

7. The information processing apparatus according to claim 6, wherein the at least one processor is further configured to control the movement of the content between the shared area and the confidential area based on a user input.

8. The information processing apparatus according to claim 1, wherein the shared area is visible to the plurality of users.

9. The information processing apparatus according to claim 1, wherein the object is one of a PC or a book.

10. A method, comprising:

acquiring visible area information of a visible area of a user of a plurality of users with respect to a presentation surface;

determining an object placed on the presentation surface;

correcting the visible area information based on each of a position of the object on the presentation surface and a height of the object;

determining, on the presentation surface, a shared area for the plurality of users and a confidential area for the user, based on the corrected visible area information;

controlling display of content including share information and confidential information, wherein

the confidential information is displayed in the confidential area,

the share information is displayed in the shared area,

the share information not being needed to be secured, and

the confidential information being needed to be secured in the shared area;

determining a movement of the content including the share information and the confidential information from the confidential area to the shared area; and

controlling, based on the determination of the movement of the content, non-display of at least a part of the confidential information to one of hide or delete the part of confidential information.

11. A non-transitory computer-readable medium having stored thereon, computer-executable instructions, which when executed by a processor of a first information processing device, cause the processor to execute operations, the operations comprising:

acquiring visible area information of a visible area of a user of a plurality of users with respect to a presentation surface;

determining an object placed on the presentation surface;

correcting the visible area information based on each of a position of the object on the presentation surface and a height of the object;

determining, on the presentation surface, a shared area for the plurality of users and a confidential area for the user, based on the corrected visible area information;

controlling display of content including share information and confidential information, wherein

the confidential information is displayed in the confidential area,

the share information is displayed in the shared area,

the share information not being needed to be secured, and

the confidential information being needed to be secured in the shared area;

determining a movement of the content including the share information and the confidential information from the confidential area to the shared area; and

controlling, based on the determination of the movement of the content, non-display of at least a part of the confidential information to one of hide or delete the part of confidential information.

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